

Serial No. 10/016,562

**CLAIM AMENDMENTS:**

1. (Original) A method of etching a dielectric structure comprising:  
providing a dielectric structure comprising (a) a first dielectric layer of undoped silicon oxide or F-doped silicon oxide; and (b) a second dielectric layer of C,H-doped silicon oxide; and  
etching said dielectric structure in a plasma-etching step, wherein said plasma-etching step is conducted using a plasma source gas that comprises nitrogen atoms and fluorine atoms, and wherein said second dielectric layer is selectively etched relative to said first dielectric layer in said etching step.
2. (Currently amended) The method of claim 1, wherein said plasma source gas comprises a gaseous species that ~~further~~ comprises one or more nitrogen atoms and one or more fluorine atoms.
3. (Original) The method of claim 2, wherein the gaseous species is NF<sub>3</sub>.
4. (Original) The method of claim 1, wherein said plasma source gas comprises (a) a gaseous species that comprises one or more nitrogen atoms and (b) a gaseous species that comprises one or more fluorine atoms.
5. (Original) The method of claim 4, wherein said plasma source gas comprises N<sub>2</sub> and a fluorocarbon gas.
6. (Original) The method of claim 5, wherein said fluorocarbon gas is CF<sub>4</sub>.
7. (Original) The method of claim 1, wherein said first dielectric layer is an undoped silicon dioxide layer.
8. (Original) The method of claim 1, wherein said first dielectric layer is a fluorinated silica glass layer.

Serial No. 10/016,562

9. (Original) The method of claim 1, wherein said plasma-etching step provides a second-dielectric-layer: first-dielectric-layer selectivity of 2.5:1 or greater.

10. (Original) The method of claim 1, wherein said plasma-etching step provides a second-dielectric-layer: first-dielectric-layer selectivity of 3:1 or greater.

11. (Original) The method of claim 1, wherein said plasma-etching step is conducted within a magnetically enhanced reactive ion etching system.

12. (Currently amended) A method of etching a trench in a dual damascene structure, said method comprising:

providing a dual damascene structure comprising (a) an underlying layer, (b) a via dielectric layer of undoped silicon oxide or F-doped silicon oxide over said underlying layer, (c) a trench dielectric layer of C<sub>2</sub>H-doped silicon oxide over said via dielectric layer, and (d) a patterned masking layer over said trench dielectric layer; and

etching one or more trenches in said trench dielectric layer through apertures in said patterned masking layer in a plasma-etching step until a portion of an upper surface of said via dielectric layer is exposed, wherein said plasma-etching step is conducted using a plasma source gas that comprises nitrogen atoms and fluorine atoms and wherein said trench dielectric layer is selectively etched relative to said via dielectric layer in said plasma-etching step.

13. (Original) The method of claim 12, wherein said dual damascene structure comprises an extended via hole that extends through said trench dielectric layer and said via dielectric layer.

14. (Currently amended) The method of claim 12, wherein said plasma source gas comprises a gaseous species that further comprises at least one nitrogen atom and at least one fluorine atom.

15. (Original) The method of claim 14, wherein the gaseous species is NF<sub>3</sub>.

16. (Original) The method of claim 12, wherein said plasma source gas comprises: (a) a gaseous

Serial No. 10/016,562

species that comprises one or more nitrogen atoms and (b) a gaseous species that comprises one or more fluorine atoms.

17. (Original) The method of claim 16, wherein said plasma source gas comprises N<sub>2</sub> gas and a fluorocarbon gas.

18. (Original) The method of claim 12, wherein said via dielectric layer is an undoped silicon dioxide layer.

19. (Original) The method of claim 12, wherein said via dielectric layer is a fluorinated silica glass layer.

20. (Original) The method of claim 12, wherein said plasma-etching step provides a trench-dielectric-layer:via-dielectric-layer selectivity of 3:1 or greater.

21. (Original) The method of claim 12, wherein said plasma-etching step is conducted within a magnetically enhanced reactive ion etching system.

22. (New) The method of claim 1, wherein said second dielectric layer of C,H-doped silicon oxide is formed using a plasma-assisted chemical vapor deposition process.

23. (New) The method of claim 12, wherein said trench dielectric layer of C,H-doped silicon oxide layer is formed using plasma-assisted chemical vapor deposition process.

Serial No. 10/016,562

**STATUS OF CLAIMS:**

Claims 1-23 are pending herein.

Claims 22 and 23 are added above. Support for new claims 22 and 23 can be found, for example, in paragraph [0031] of the present specification.

Claims 2, 12 and 14 are amended above. Support for the amendment of claim 12 can be found, for example, in originally filed claim 1. Claims 2 and 14 are amended to eliminate "further," as this term is superfluous.

**REMARKS**

**A. Rejection of Claims 1-7 under 35 U.S.C. 102**

Claims 1-7 are rejected under 35 U.S.C. 102(e) as being anticipated by Maex et al. (U.S. 2002/0076935). Applicants respectfully traverse this rejection and its supporting remarks.

For example, independent claim 1 is directed to a method of etching a structure that comprises a first layer of undoped silicon oxide or F-doped silicon oxide and a second layer of C<sub>x</sub>H-doped silicon oxide. The structure is etched in a plasma-etching step, which is conducted using a plasma source gas that comprises nitrogen atoms and fluorine atoms, and which selectively etches the second layer of C<sub>x</sub>H-doped silicon oxide relative to the first layer of undoped silicon oxide or F-doped silicon oxide. Such a method is neither taught nor suggested by Maex et al.

The Office Action alleges that Maex et al. describes a method that comprises providing a dielectric structure that comprises (a) a first dielectric layer such as undoped silicon oxide, and (b) a second organic low-k dielectric layer, such as BCB, FLARE or SILK, which is asserted to correspond to the claimed layer of C<sub>x</sub>H-doped silicon oxide.

However, neither BCB nor FLARE nor SILK is a C<sub>x</sub>H-doped silicon oxide material as claimed. In fact, these materials are organic polymer layers. See, e.g., paragraph [0074] (emphasis added): "A first dielectric layer (12), i.e. an *organic polymer layer* comprising phenyl groups is formed on a substrate (11) ... Examples of such polymers are the benzocyclobutarenes, i.e. benzocyclobutene (BCB) commercially available as Cyclotene 5021™ poly arylene ether, i.e. FLARE™ II, aromatic hydrocarbon, i.e. SILK™, polyimides."

Serial No. 10/016,562

It is noted that paragraph [0092] of Maex et al. describes a single damascene stack (illustrated in Fig. 11), which consists of (starting at the Si substrate): (a) 50 nm SiN, (b) 500 nm SiO<sub>2</sub>, (c) 50 nm BloK, (d) 500 nm TMS—O<sub>3</sub>, and (e) 100 nm BloK. The description of Fig. 10 indicates that the TMS—O<sub>3</sub> layer utilized is a Black Diamond™ low-K layer. Black Diamond™ is an exemplary C<sub>x</sub>H-doped silicon oxide material set forth in the present specification. See paragraph [0031] of the present specification.

However, as noted in paragraph [0093], Maex et al. does not etch the Black Diamond™ low-k material using a plasma source gas that comprises nitrogen atoms and fluorine atoms as claimed in claim 1. Instead, the Black Diamond™ material is etched using a mixture of Ar, CF<sub>4</sub>, CHF<sub>3</sub> and O<sub>2</sub> as a plasma source gas.

Furthermore, the Black Diamond™ layer is *not* selectively etched relative to a layer of undoped silicon oxide or F-doped silicon oxide as claimed in claim 1, but is rather etched in the presence of resist and BloK hard mask layers. As noted in paragraph [0092] of Maex et al., BloK is an SiC material.

For at least the above reasons, it is respectfully submitted that claim 1 is neither anticipated nor obvious in view of Maex et al. Claims 2-7, which depend from claim 1, are patentable over Maex et al. for at least the same reasons.

Accordingly, reconsideration and withdrawal of the outstanding rejection of claims 1-7 under 35 U.S.C. 102(e) are respectfully requested.

**B. Rejection of Claims 8 and 12-20 under 35 U.S.C. 103(a)**

Claims 8 and 12-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maex et al. in view of Chen et al. (U.S. Patent No. 6,573,187). Applicants respectfully traverse this rejection and its supporting remarks.

In order to establish a *prima facie* case of obviousness under 35 U.S.C. 103, (a) there must be some suggestion or motivation to modify/combine the references of record, and (b) there must be a reasonable expectation of success. See MPEP §2143. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in applicant's disclosure. *Id.* The mere fact that references *can* be combined or modified does not render the resultant combination obvious unless the prior art also suggests the

Serial No. 10/016,562

desirability of the combination or modification. MPEP 2143.01 (emphasis added) (citing *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990)).

As seen from the above discussion, Maex et al. is deficient with respect to independent claim 1 (and with respect to independent claim 12 as well) at least in that it does not teach or suggest a process in which a layer of C<sub>x</sub>H-doped silicon oxide is etched using a plasma source gas that comprises nitrogen atoms and fluorine atoms. Moreover, Maex does not teach or suggest a process in which a layer of C<sub>x</sub>H-doped silicon oxide is selectively etched relative to a layer of undoped silicon oxide or F-doped silicon oxide.

Chen et al. does not make up for these deficiencies in Maex et al.

For example, Chen et al. does not appear to contain any teachings whatsoever concerning etching chemistry, much less an etching chemistry that is capable of selectively etching C<sub>x</sub>H-doped silicon oxide relative to undoped silicon oxide or F-doped silicon oxide.

The Office Action alleges that Chen describes a method for forming a dual damascene structure having a via dielectric layer of undoped or F-doped silicon oxide 30 under a layer of C<sub>x</sub>H doped silicon oxide 32 such as FLARE™, SILK™ and Black Diamond™.

As noted above, FLARE™ and SILK™ are organic polymers, rather than C<sub>x</sub>H doped silicon oxide as claimed.

As to providing undoped or F-doped silicon oxide in combination with Black Diamond™ C<sub>x</sub>H doped silicon oxide, Chen et al. at col. 4, lines 28-35 merely teaches that dielectric layers 30 and 32 can contain "any suitable dielectric material such as SiO<sub>2</sub>, Fluorine doped SiO<sub>2</sub>, USG, Flare, Silk or Black Diamond or any other suitable low-k dielectric material." Hence, Chen et al. teaches nothing more than the fact that the two dielectric layers can be formed from *any* suitable low-k material. It is respectfully submitted that this vague disclosure falls far short of teaching the desirability of providing a C<sub>x</sub>H doped silicon oxide layer (Black Diamond™) in combination with an undoped or F-doped silicon oxide layer as presently claimed.

For at least these reasons, it is respectfully submitted that claims 1 and 12 are unobvious over Maex et al. in view of Chen et al. Claims 8 and 13-20, which depend directly or indirectly from either claim 1 or claim 12, are also unobvious over Maex et al. in view of Chen et al. for at least the same reasons.

Accordingly, reconsideration and withdrawal of the outstanding rejection of claims 8 and 12-20 under 35 U.S.C. 103(a) are respectfully requested.